

great as to lead to the general adoption (by continental makers) of small circles with powerful reading micro-meters in place of large circles with verniers.

A very simple process of making relief maps in Germany is described, viz. by cutting out contour strips from a contoured map, and pasting each on to cardboard cut to same outline. Altogether the Report is a very interesting one.

ALLAN CUNNINGHAM

### GREEN'S "GEOLOGY"

*Geology.* By A. H. Green. Part I. Physical Geology. Third and Enlarged Edition. (London: Rivingtons, 1882.)

STUDENTS of Geology will welcome this third and much enlarged edition of Prof. Green's excellent text-book, though they may at first sight regret the exchange of the old convenient manual form of the book for that of the present handsome and well-printed octavo. One of the first features that strikes the reader in this new issue of the work is the large augmentations made to the lithological sections. In fact this part of the treatise may be said to have been re-cast and almost wholly re-written. The author devotes 150 closely printed pages to crystallography and the description of minerals. It may be open to question whether the full details which he gives to the crystallographic characters of minerals are not rather out of place in a geological treatise. They are not ample enough for the mineralogical student, and the geologist who takes up the subject must necessarily study text-books of mineralogy, where they are given at much greater length. Prof. Green, however, has put them so clearly and succinctly that this portion of his book cannot fail to be of use.

Some changes have been made in the arrangement of rocks. The non-crystalline or derivative rocks now come first—a grouping which no doubt has its advantages in teaching, particularly in elementary classes, but which is not that usually employed in petrographical works. After briefly describing the lithological character of the non-crystalline rocks, the author, following his original plan, proceeds to discuss the mode of formation of these rocks, dealing first with denuding agents and their work, and then considering the manner in which the denuded material is aggregated into rock-masses. In these sections he brings his subject abreast of the onward march of the science. Another change in the original treatment of his subject occurs in the author's chapter on the "confusedly crystalline rocks." He has not been so happy in his choice of a title for them as he has been in his description of their general characters. After giving an account of the lithological features he proceeds to discuss their modes of origin, dealing first with volcanoes recent and extinct, then with earthquakes (though one wonders what these have to do with a description of crystalline rocks), next with plutonic rocks which, however, are rather inadequately discussed. The chapter on metamorphic rocks has been carefully revised, and may be commended to the student as an admirable summary of what is at present known on this subject. The chapter upon the way in which rocks came into their present positions was one of the best in the first edition of the book. Its excellence has now been increased by a thorough revision. For

practical insight into the structure of the earth's crust it is unsurpassed in any treatise known to us.

Prof. Green more than makes up for the curious omission in the first edition of any mention of mineral veins. We doubt, however, the advantage of inserting minute descriptions of metallic ores in a general geological text-book. The author would do well in his next edition to give references to the Continental works on mining, particularly to some of the numerous treatises which have been published in Germany. Chapter XIII. retains its place as a valuable account of how the present surface of the ground has been produced. The last two chapters discuss the former fluidity and present condition of the earth's interior, the cause of upheaval, contortion, and metamorphism, and the origin of the changes of climate which have taken place during geological time. These parts of the book are exceedingly well done. The author has held the balance fairly between contending disputants, and sums up the evidence with conspicuous and judicial impartiality. Altogether, he may be congratulated on the appearance of this edition of his text-book, which sustains and extends his reputation as an exponent of his favourite science.

### OUR BOOK SHELF

*A History of British Birds.* By the late William Yarrell. Fourth Edition, Revised to the end of the Wryneck, by Alfred Newton, M.A., F.R.S., continued by Howard Saunders, F.L.S., F.Z.S. Part XV. (London: John Van Voorst, November, 1882.)

THE fifteenth part of the new edition of what the British ornithologist fondly calls his "Yarrell" contains the final contribution of Prof. Newton to this work, and the first pages of the portion which Mr. Howard Saunders, his successor in the editorship, has undertaken. Few of the subscribers, we believe, will be much pleased with the change of authorship of their favourite work of reference. No living writer, it may be confidently asserted, is so competent to prepare a new edition of "Yarrell's British Birds" as Prof. Newton, and the conscientious care with which he has laboured upon the two volumes now completed must be patent to all who consult them. At the same time it should not be forgotten that time is an element in all human matters not even excepting books on British birds. When, therefore it is considered that nearly eleven years have elapsed since Prof. Newton commenced his new edition, and that only the first half of the work is now completed, it is obvious that the Professor has not acted unwisely in surrendering the second half to an editor who is able to devote more time to the undertaking.

Mr. Howard Saunders, it is generally understood, intends to issue the two final volumes of the new edition in two years, and if his health and strength permit, will doubtless accomplish his task within the allotted period. In this his large practical knowledge of the bird-life of Southern Europe, as well as his well-known familiarity with modern ornithological literature, are likely to be of the greatest assistance.

Mr. Saunders commences his second volume with the pigeons, and gives us an excellent account of the four British species, as also of the American passenger pigeon, which can only be looked upon as one of our rarest stragglers from the New World. When, however, he says that all true pigeons lay two eggs he must have forgotten that the crowned pigeons, and the numerous forms of fruit-pigeons are, so far as is known, content to lay but one. There is therefore no good reason for calling the

Columbæ "Bipositores," as one of our systematists has proposed to do! After the pigeons Mr. Saunders places the sand-grouse as an intermediate order between the Columbæ and Gallinæ. This is certainly a better plan than that adopted by some of the more ardent reformers of the ornithic system—of uniting the sand-grouse in the same group with the pigeons, and thus spoiling the symmetry of the order Columbæ. In this and in other particulars the new Editor of "Yarrell's Birds" show a judicious spirit, which cannot fail to make the results of his labours generally acceptable.

*Episodes in the Life of an Indian Chaplain.* By a Retired Chaplain. (London: Sampson Low, Marston, Searle, and Rivington, 1882.)

THIS interesting narrative of the adventures and vicissitudes of a devoted and single-minded Indian Chaplain, appears to be addressed to two classes of readers. A considerable portion must be considered more or less theological, and hence not applicable to the columns of NATURE; but running throughout the unambitious work is a considerable residue of facts and observations relating to zoology, which are never tiresome and sometimes original. In the days of his boyhood our author's leisure time was given to his "different collections of natural history and antiquities," and after many years' official duties he seems to have once more resumed his early tastes, on his appointment to the curatorship of the museum and secretaryship of the public gardens belonging to the Maharajah of Travancore. It is whilst employing his leisure in this vocation that the reader experiences more of the naturalist and less of the chaplain, but both phases are so kindly and modestly described, as to disarm criticism and at the same time promote an amiable impression of the writer.

#### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

#### Sir George Airy on the Forth Bridge

SIR GEORGE AIRY'S letter (*vide* NATURE, vol. xxvi. p. 598) criticising Messrs. Fowler and Baker's design for the Forth Bridge is so important, that I think it but right, as I am not without experience on the subject, to make some remarks on the subject of it. Sir George Airy states:—

1. "That the proposed construction is, as applied to railway bridges, entirely novel." This is not quite exact. There are a number of cantilever bridges in America; and I have, myself, used practically similar principles of construction and erection, on a large scale, with entire success, and find them so satisfactory that, for a very long span, I would not think of using any other.

2. "The magnitude of its parts is enormous." Undoubtedly they are—and all the more credit to the men who had the nerve to design them.

3. "There has been no succession of instances of the construction with rising degrees of magnitude which might furnish experimental knowledge of some of the risks of construction." If this reason were sound, the same objection would have prevented the construction of the Conway, Britannia, and Saltash bridges, and *Great Eastern* steamer; but so far from the statement being correct, the engineering profession has gained ample experience in the erection of the St. Louis, Kentucky River, Douro and Minnehaha bridges to give assurance that the Forth Bridge can be made a perfect success.

4. "The safety of the bridge depends entirely on a system of end thrusts upon very long rods." This is a very singular statement. What would become of the safety of the bridge in case there was no answering and complementary tension system equally exposed to danger from a "system of end pulls upon

very long rods" does not appear from Sir George's letter; nor does he seem to remember that the tests of the last few years show conclusively, that iron exposed to compression within its buckling limit is compacted in texture and strengthened by such use while, if subjected to continuous tension beyond two-thirds of its elastic limit, it is attenuated and weakened.

5. "No reference is made to theory applied to the buckling of rods under end thrusts." None was necessary. Mr. Baker has designed struts, or columns—not rods. These members in the Forth Bridge are presumed to have such a proportion of diameter to length that the question of buckling does not come into consideration. In America, columns of many shapes—in full-sized sections—have been tested in lengths of from 10 to 70 diameter, and the value of these shapes, in pounds of resistance per square inch of section for each  $\frac{\text{length}}{\text{diameter}}$  is definitely known.

These results are now the common property of all English-speaking engineers. Sir George Airy's remarks on long struts are the more extraordinary, as there is in England, in the upper chord of the Saltash Bridge, an example of a long strut without lateral support which is greater in its ratio of length to diameter than any member that I know of in the Forth design. Moreover, it is 455 feet long, near enough to the length of St. Paul's Cathedral for him to contemplate in connection with that edifice, in presenting a picture to the people of London.

6. "The liability to ruinous disturbance by the lateral power of the wind acting with the leverage of the long brackets appears to be alarmingly great." This liability to destruction by wind is common to all large spans; but the danger is greater in the case of a suspension bridge than in any other (I speak with some knowledge on this point, having made the effects of tornadoes a special study for a number of years past, and having visited most of the bridge wrecks which have occurred in the States, from this cause, since 1858). So far as destruction by wind can be guarded against in the Forth design, it has apparently been done; and the bridge will be vastly stronger in this regard than many other bridges in England which can be easily named, and about the strength of which there is supposed to be no question.

To conclude:—The opinion of those American engineers with whom I have conversed on the subject, and whose experience in building long-span bridges makes that opinion valuable, is uniformly to the effect that the design of Messrs. Fowler and Baker is well digested, perfectly practicable as to execution, and thoroughly permanent in character when finished.

I may also add that three years since, when called on to design a railway bridge for the crossing of the Great Colorado cañon, which was to be 900 feet span and 750 feet above the river, I investigated the relative merits and cost of the various systems—arch-suspension and cantilever with mid-span. Working drawings were made of each, and the result was, that the cantilever was adopted as being equally strong and stable—less liable to be affected by wind and thermal changes, and decidedly more economical in first cost and easier of erection than either of the others. I am, therefore, not surprised that the engineers of the Forth Bridge should have reached the same conclusion.

CHARLES SHALER SMITH

St. Louis, Mo., November 11

#### The Aurora

I HAD not the good fortune to see the very unusual phenomena which took place during the aurora of Nov. 17. It was, however, well seen by four of the students of this College, Messrs. Sykes, Wildeblood, Thornhill and Wackrill. Although you are doubtless inundated with letters on the subject, I send a short account of the observation, as such an opportunity of determining the height of an auroral light very rarely occurs. The commencement of the movement of the "Whitehead-torpedo-shaped" streak of light does not appear to have been noticed by them; it passed however just below the moon, one observer thinks that its upper edge just grazed the lower edge of the moon. The light when close to the horizon bore due south-west, a position which has since been verified by bearings taken by a prismatic compass. The spot where the observers stood is, by the new ordnance map in lat.  $51^{\circ} 25' 57''$  N., and long.  $0^{\circ} 34' 5''$  W.

HERBERT MCLEOD

Royal Indian Engineering College, Cooper's Hill, Nov. 24

At Ilford, Essex, on the 17th instant, at 6h. 4m. p.m. by a watch which was within 2m. of G. M. T., I witnessed, during